OnLine Journal of Biological Sciences

Original Research Paper

Endemics and Subendemics Species Diversity of Ketpen Ridge Flora

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Article history
Received: 29-07-2017
Revised: 05-09-2017
Accepted: 11-10-2017

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Abstract: The article considers endemic and subendemic species composition of Ketpen ridge flora. It has been educed that in the Ketpen ridge flora there are 46 endemic and subendemic species belonging to 28 genera and 17 families. Peculiarly, there are only 5 species belonging to 5 genera and 5 families: Endemic species of the Ketpen ridge: Fabaceae, Boraginaceae, Asteraceae, Zygophyllaceae and Brassicaceae. There are 41 species of subendemic species. The largest number of subendemic species contains the families of Asteraceae (15 species), Fabaceae (9 species), Liliaceae (4 species) and Brassicaceae (4 species). A wide range of species such as *Astragalus* (8 species), *Galatella* (4 species), *Tulipa* (4 species), *Oxytropis* (3 species), *Saussurea* (3 species), *Taraxacum* (2 species), *Alchemilla* (2 species), *Achoriphragma* (2 species) stand out among the genera. The analysis of life forms has showed that 58.2% of endemic and subendemic species belongs to the core polycarpous plants that are represented in the families of Fabaceae (11 species), Asteraceae (7 species), Brassicaceae (4 species), Lamiaceae (2 species) and a small percentage (10.8%) is represented by bulbous perennials and short-stemmed polycarpicles (6.5%).

Keywords: Flora, Endemics, Subendemics, Ketpen Ridge

Introduction

The study of the mountainous areas flora at the present stage is of great scientific interest. Particularly, flora study of some under-investigated regions located in a desert zone is relevant. One such region of the Northern Tien-Shan located in the territory of Kazakhstan is the Ketpen ridge. The eastern part of the ridge located in the territory of Kazakhstan is called Ketpen and its western part from the China side is called Temerlik (Fig. 1). The Ketpen ridge flora has been studied for more than 12 years.

Throughout its entire length, the northern slope of the Ketpen ridge is heterogeneous in its geomorphologic structure. It is subdivided into the following geomorphological regions: 1. Mountainous area with absolute elevations of 1300-3600 m. 2. Piedmont penchant steeply -sloping undulating plain with absolute elevations of 800-1600 m above sea level. 4. The Prianli basin with absolute elevations of 500-650 m (Shultz, 1933).

The climate of the Ketpen ridge area is sharply continental that is specified by large annual and diurnal amplitudes of temperature fluctuations. The average air temperature in January by the Chunja meteorological station is minus - 11,2 degrees Celsius, in July + 24,5 degrees Celsius (Agroclimatic, 1970; Rybin, 1952).

According to the physiographical zoning of Kazakhstan (Chupakhin, 1970), the Ketpen ridge refers to the Central Asian country, the Tien Shan Region, the North Tien Shan Province, the Chilik-Ketpen region and two districts: the northern slope of the Ketpen Ridge and the Kegen-Tekes.

The vegetation cover of the area under study reflects the complex natural climatic conditions of the mountain landscape due to the rapid change in altitudinal belts, a variety of relief forms, the ridge location in the desert zone. The maximum altitude of the Ketpen ridge slightly climbs above 3600 m in the eastern part and 3400 m in the western without reaching the boundary of permanent snow, therefore there is no nival and ice zone on the Ketpen ridge.

The investigated Ketpen ridge has been conditionally divided into three altitudinal belts: high-altitude, medium-altitude and low-altitude, in which piedmont and submontane belts have also been distinguished. High-altitude belt forms the alpine and subalpine belts. 1. The belt of deserts and semi-deserts - stretches from 600 to 900 m above sea level. 2. Steppe belt - is located at a height of 900 m to 1500 m below sea level. 3. Belt of bushes and deciduous forests - is at a height of 1500-1800 m. 4. Subalpine belt or belt of spruce forests - reserves altitude limits from 1800 to 2900 m. 5. Alpine belt - starts from 2900 m and reaches 3500 m below sea level (Fig. 2).

The following types of vegetation are represented on the Ketpen ridge: Deserts, steppes, forests, meadows, marshes.

The aim of the study has been to identify the taxonomic composition and study the distribution of the ecology, the biology of endangered rare endemic and subendemic species of the Ketpen ridge in terms of knowledge on endemic flora and its conservation. The objectives of the work are to perform counts of endangered rare endemic and subendemic species composition of the Ketpen ridge and as well as to compile a complete list of species that we have identified.

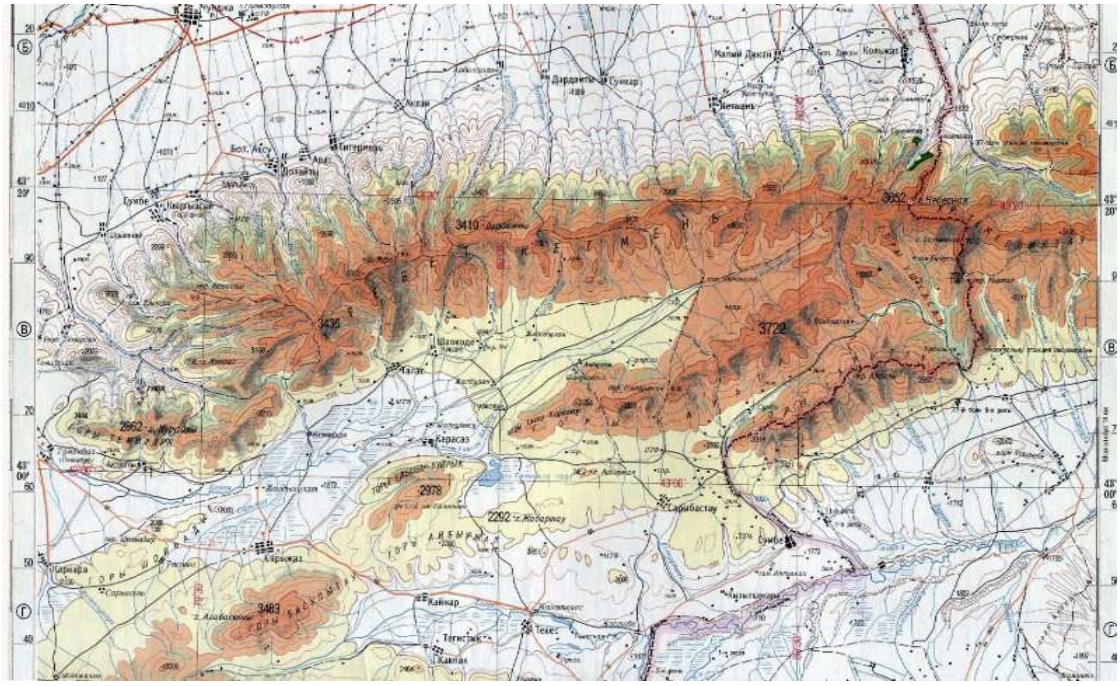

Fig. 1. General map of the Ketpen ridge. Source: http://xtreme.rip/books/1644186-skachat-topograficheskie-karty-kazahstana-2003-png-besplatno.html

(a)

(b)

(c) (d)

Fig. 2. The Ketpen Ridge (a) Forest belt (b) Shrub belt (c) Lower belt (d) Alpine belt. Source: Authors archives

Materials and Methods

The work on studying endemic and subendemic species flora of the Ketpen ridge was collected and supplemented from 2003 to 2015. During this period, more than 30 expeditions were carried out in various areas of the Ketpen ridge.

The total area of the investigated Ketpen ridge territory within Kazakhstan is about 13,500 km^2.

The material for writing this work were herbarium specimens that were collected during the research expeditions with the author's participation on the Ketpen Ridge (2003-2015), as well as the collections kept in the collections of the Institute of Botany and Phyto-Intrusion of the Republic of Kazakhstan. A total of more than 1000 herbarium sheets of endemic or closely related species were critically examined and identified, 17 sample specimens were studied. In addition, for the creation of a list of endemic and subendemic species of the study area, literary data were used from numerous floristic reports (Flora of the USSR, Flora of Kazakhstan, Plants of Central Asia, Plant Identifier of Central Asia, etc.) and monographic works on individual taxa.

The main methods of studying endangered rare endemic and subendemic plant species of the Ketpen ridge were conventional methods of botanical and floristic studies and traditional methods of geobotanical research: Under field conditions, the traditional route-reconnaissance method was used. The collection and processing herbarium materials were carried out under the standard practice. Specimens of rare endemic and subendemic plant species were collected in herbarium files with the description of collection sites, dates and collectors. At points fixed on the ground by the GPS device, a detailed geobotanical description of the found vegetation communities was carried out. Cameral treatment, species identification were carried out in the laboratory: After field works the material was subjected to additional drying and viewing by mean of binocular loupes and classified into systematic groups.

Collecting and processing the herbarium material was carried out under common method of Skvortsov (1977). In the process of determining the herbarium, multivolume reports were used as sources: “Flora of the USSR” (1934-1964), “Flora of Kazakhstan” (1956-1966), “IDPK” (1962-1975), “PCA” (1963-1989), “Plant Identifier of the Central Asia” (1968-1993), Tsvelev (1976) and others. For an update on the specific and generic namatophilous, the last summaries of Cherepanov (1995; Abdulina, 1998) were used. Types of life forms are conducted under the classifications of Serebryakov and Raunkier (1962).

Results

The work on studying the endemic and subendemic species flora of the Ketpen ridge within the boundaries of Kazakhstan was conducted for 12 years.

For the analysis of the flora of a particular region, the study of endemic species is of great importance, since they are indicators of the authenticity and originality of a certain flora (Kamelin, 1973).

As the result of multi-year research of the Ketpen ridge flora of the within the boundaries of Kazakhstan and generalization of all available literature data on the subject as well enabled to identify 1766 species of vascular plants belonging to 593 genera and 111 families.

In regards to species composition on the Ketpen ridge flora, Magnoliophyta department dominates which accounts for 98.4% and only a small number of 1,6% species refers to Pinophyta, Polypodiophyta, Lycopodiophyta and Equisetophyta (Fig. 3). This ratio of groups is common for the flora of Mountainous Central Asia and the Holarctic as a whole (Kamelin, 1973).

The ratio of monocotyledonous and dicotyledonous groups in the Ketpen ridge flora is approximately 1:5.4, i.e., Magnoliopsida prevails over Liliopsida in specific and generic composition more than 5 times. The total number of monocotyledonous plants covers 350 species, or 18,4% of the total number of species; there are 1510 species, or 80% of dicotyledonous plants (Fig. 4).

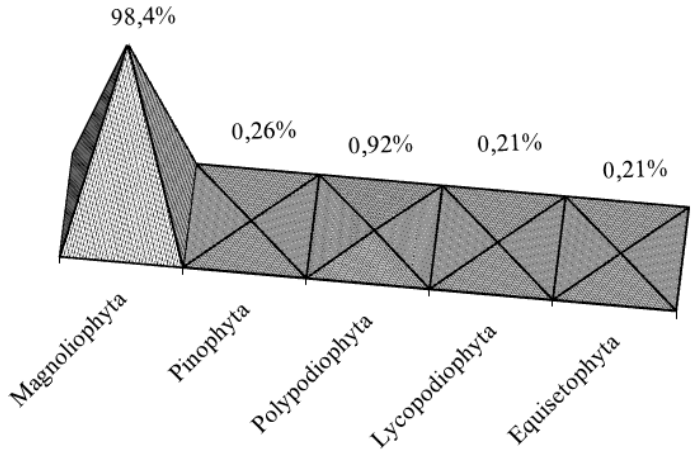

Fig. 3. Systematic groups ratio of the Ketpen ridge flora

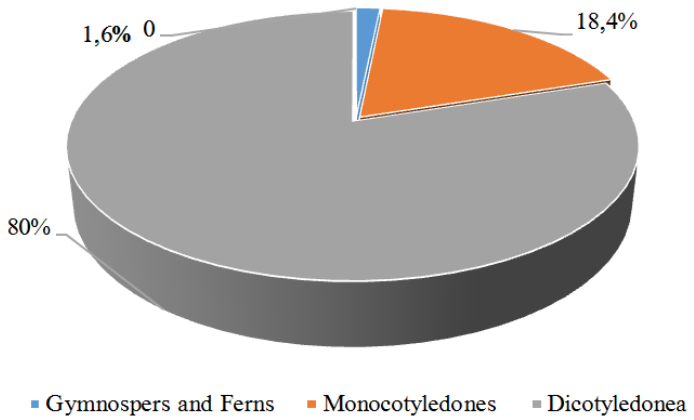

Fig. 4. The general composition of the Ketpen ridge flora

Such ratio of the species number of monocotyledonous and dicotyledonous plants according to Kamelin (1973) is typical for the flora of the Eastern part of Ancient Middle-earth.

For the purpose of studying the population state of rare endemic and subendemic plant species, expeditionary studies of the Ketpen ridge were conducted starting from the east at the border with China. The study covered the territories of two districts (Uigur and Raiymbek). Floristic collections compiled during research seem to be quite complete, although they do not deplete all the species wealth of the endemic and subendemic flora of the Ketpen ridge.

The general patterns of endemics distribution in the territory of Kazakhstan and especially in mountain areas are covered in monographs and scientific articles of many researchers.

Rubtsov (1964) cites endemic and relict species of the Northern Tien Shan in his works, where he notes that relic endemism is present in the composition of the North Tien Shan flora. Both the generic and the species endemism of the Central Asia flora are strongly pronounced in the mountain part of it. The mountainous Central Asia is distinguished by strikingly rich endemism. About 60 generic endemics are concentrated here and at least a thousand are shown as endemic species. At the same time, the majority of endemic genera and species are found on the foothills and low-mountain or middle belts of the mountains. However, there are many endemic genera confined exclusively or mainly to the high-altitude subalpine and alpine belts. This group of highland patrimonial endemics is of special botanical-geographical interest, since its origin is apparently related to the newest phases of orogenesis with the last stages of the Central Asian mountain systems formation.

The flora of the Northern Tien Shan numbering about 3000 species contains 160 endemic species, which is 5,3%, herein, a low percentage of endemism is explained by significant links between the mountain systems of the Northern Tien Shan and the ridges of adjacent mountain regions (Baitenov, 1985).

The Ketpen ridge in the number of endemic species does not belong to the rich floristic regions of

the Tien Shan such as the Syrdarya Karatau, the Dzhungar Alatau, the Trans-Ili Alatau, or the Chu-Ili Mountains. Rare and endemic plants on the Ketpen ridge are found in small, often single quantities, sometimes in a single place. The presence of a small number of endemics of the Ketpen ridge flora on the one hand is due to the fact that the Ketpen ridge as a mountain system is not insulated and its boundaries in the south and in the west are very conventional. On the other hand, the general explanation of the geological formation of the Tien Shan mountain system is the reason explaining the low endemism of the given territory.

Taxonomic Analysis

In the analysis of endemic elements, it has been discovered that the largest number of endemics occur in extensive polymorphic genera indicating a young progressive neoendemism. This applies in particular to genera such as *Poa*, *Agropyrum*, *Allium*, *Astragalus*, *Oxytropis*, *Lappula*, *Artemisia* (Rubtsov, 1964).

There are no endemic families in the flora of the Ketpen ridge. As for the generic endemics, for the Northern Tien Shan, Rubtsov (1964) gives six genera, among them for the Ketpen ridge is named only one monotypic genus *Seselopsis* with a single species - *Seselopsis tianschanicum* Schischk growing in the subalpine belt.

The total number of endemics and subendemics is 47 species or 2.6% of the total composition of flora belonging to 28 genera and 17 families, only 5 of which are endemic Ketpen ridge species (Table 1).

The most numerous in the species relation is the group of subendemics (42 species or 2,36%), which is typical for the Ketpen ridge and for neighbouring ridges.

The subendemics of the Ketpen ridge belong to 23 families, 23 genera and 42 species. Most representative in relation of the endemism are family *Asteraceae* (15 species), *Fabaceae* (11 species) and *Liliaceae* (4 species) (Table 2).

Geographical Analysis

The analysis of the spatial relations of the Ketpen ridge subendemics has revealed the flora community of this region with more remote mountain mass. Thus, meadow and desert-steppe species (7 and 4 species, respectively) are common to the Ketpen and Jungar Alatau ridges; Alatau - meadow species (6 species), desert-steppe species (6 species) growing on gypsophils, tertiary clays, variegated formations (6 species) are common for the Ketpen and Zailiyskiy and Kyrgyz Alatau ridges, with Terskei Alatau - desert-steppe types of foothills (3 species), meadow species (5 species).

There are only five endemic species. They belong to five genera and five families: Fabaceae, Boraginaceae, Asteraceae, Zygophyllaceae, Brassicaceae. As a part of families there is a psammophyte glacial relict - *Astragalus rubtzovii* Boriss. - neoendemic with Quaternary age.

As the result of the endemism index calculation of the Ketpen ridge flora according to (Bykov, 1979) we obtained an indicator equal to-1,8. It is characterized as lowered.

Five endemic species, which for our ridge make up only 0,36% of the total number of flora, are narrow, or "pure" endemics growing only in this area. All of them belong to the group of dicotyledonous plants, to eleutheropetalous. One of them is *Astragalus rubtzovii* Boriss., which is a mesoxerophyte - that is confined to the relic sands "Kum-Tekei" (Baitenov, 1975), the second is *Oxytropis ketmenica* Saposhn. - grows on the meadows of the upper belt; the third is *Zygophyllum cuspidatum* Boriss. - xerophyte growing on deserted rubbly slopes of the foothills, the fourth is *Lepidium rubtzovii* Vass. - grows on tertiary salt-bearing clays in the Kegen valley, in the middle reaches of the river Kegen. The next species is *Lappula ketmenica* Kudabaeva-grows in the steppe communities of the middle belt.

In the family *Fabaceae* there are 2 genera and 11 species, most of which belongs to the genus *Astragalus* (8 species) and genus *Oxytropis* (3 species). The family contains 2 Ketpen-Zailiyskiy endemic, 4 Jungaro-Ketmen endemic, 1 Ketpen-Terskei endemic, 1 Ketpen-Kyrgyz endemic and one Jungar-Ketpen-Zailiyskiy endemic.

The family Asteraceae includes 9 genera and 15 species, 3 of which belong to the genus *Saussurea*, 4 species – to the genus *Galatella* and one species is contained in the genera *Erigeron*, *Pyrethrum*, *Kaschgaria*, *Artemisia*, *Ligularia*, *Scorzonera* and *Taraxacum*. Totally there aref 6 Ketpen-Zailiyskiy endemics, 4 Ketpen-Terskei endemics, 2 Jungar-Ketpen endemics, 2 Ketpen-Terskei-Zailiiskiy endemics and 1 Jungar-Ketpen-Zailiyskiy endemic. In the family Liliaceae there are 4 species. Among them there is 1 Jungar-Ketmen endemic, 1 Ketpen-Zaili endemic, 1 Ketpen-Kungei-Zailiyskiy endemic. Among them three species of the Brassicaceae family, one species belongs to the genus *Achoriphragma*, the second to the genus *Erysimum*. The family contains 3 Ketpen-Zailiyskiy endemics. In the family Lamiaceae there are 2 species; one belongs to the genus Phlomoides, the second belongs to the genus *Lagochilus*. The family contains 2 Ketpen-Zailiyskiy endemics. The Rosaceae family includes 1 genus *Alchemilla* containing only 2 species: Ketpen-Terskei and Jungar-Ketpen-Terskei endemic.

The remaining 7 families - Alliaceae, Poaceae, Scrophulariaceae, Apiaceae, Plumbaginaceae, Rhamnaceae, Berberidaceae - contain in their composition 1 genus and 1 species. *Allium*, *Rhamnus* and *Elymus* are Ketpen-Zailiyskiy species, *Pedicularis* is Ketpen-Terskei endemic, *Berberis* is the Jungar-Ketpen-Zailiyskiy species and *Seselopsis* is a Ketpen-Kashgar endemic (Table 3).

Table 1. Species composition of endemic and subendemic plants of the Ketpen ridge

Family	Genus	Species
Apiaceae	*Seselopsis*	*Seselopsis tianschanica*
Boraginaceae	*Lappula*	*Lappula ketmenica*
Scrophulariaceae	*Pedicularis*	*Pedicularis maximowiczii*
Lamiaceae	*Phlomoides*	*Phlomoides zenaides*
Asteraceae	*Erigeron*	*Erigeron violaceus*
	Galatella	*Galatella tianschanica*
		G. polygalloides
		G. saxatilis
		G. regelli
	Pyrethrum	*Pyrethrum semenovii*
	Kaschgaria	*Kaschgaria brachanthemoides*
	Artemisia	*Artemisia transiliensis*
	Ligularia	*Ligularia knorringiana*
	Saussurea	*Saussurea caespitans*
		S. sallemani
		S. ninae
	Scorzonera	*Scorzonera transiliensis*
	Taraxacum	*Taraxacum kok-saghyz*
		T. calcereum
Zygophyllaceae	*Zygophyllum*	*Zygophyllum cuspidatum*
Brassicaceae	*Achoriphragma*	*Achoriphragma beketovii*
		Erysimum croceum
	Erisimum	*Lepidium rubtzovii*
	Lepidium	
Rosaceae	*Alchemilla*	*Alchemilla michelsonii*
		A.lipschitzii
Fabaceae	*Astragalus*	*Astragalus rubtzovii*
	Oxytropis	*A. amabilis*
		A. saccocalyx
		A. dscharkenticus
		A. abramovii
		A. chlorodonthus
		A. semenovii
		A. tekessicus
		Oxytropis ketmenica
		O. cana
		O. bosculensis
Poaceae	*Elymus*	*Elymus glaucissimum*
Alliaceae	*Allium*	*Allium lasiophyllum*
Liliaceae	*Tulipa*	*Tulipa heterophylla*
		T. brachystemon
		T. iliensis
		T. kolpakowskiana
Plumbaginaceae	*Ikonnikovia*	*Ikonnikovia kaufmanniana*
Primulaceae	*Kaufmannia*	*Kaufmannia semenovii*
Rhamnaceae	*Rhamnus*	*Rhamnus songorica*
Berberidaceae	*Berberis*	*Berberis iliensis*
Betulaceae	*Betula*	*Betula jarmolenkoana*

In this regard, it is interesting to see how endemic and subendemic species of the Ketpen ridge are allocated according to habitats, more precisely by vegetation type, territorial and altitudinal positions.

Should we consider the distribution of subendemic and endemic species according to the altitude position, we can note the following: In the low mountains 24 species are concentrated, in the middle belt there are 19 species, in the highlands - 3 species.

Table 2. Taxonomic composition of endemic and subendemic plants of the Ketpen ridge

Family	Number of genera in the family	% of the total number of genera	Number of species in the family	% of the total number of species
Asteraceae	9	39,1	15	32,6
Fabaceae	2	8,7	11	19.5
Brassicaceae	3	13,0	3	8,7
Liliaceae	1	4,3	4	8,7
Rosaceae	1	4,3	2	4,3
Lamiaceae	2	8,7	2	4,3
Apiaceae	1	4,3	1	2,1
Boraginaceae	1	4,3	1	2,1
Scrophulariaceae	1	4,3	1	2,1
Zygophyllaceae	1	4,3	1	2,1
Poaceae	1	4,3	1	2,1
Alliaceae	1	4,3	1	2,1
Berberidaceae	1	4,3	1	2,1
Plumbaginaceae	1	4,3	1	2,1
Primulaceae	1	4,3	1	2,1
Rhamnaceae	1	4,3	1	2,1
Total:	28	100	47	100

Table 3. Distribution of endangered rare, endemic and subendemic species of the Ketpen ridge along the natural area

Species	Endemic of the Ketpen	Endemic of the North Tien-Shan	Subendemic of the Ketpen
Ikonnikovia kaufmanniana (Regel) Lincz.	-	-	+
Kaufmannia semenovii (Herder) Regel	-	-	+
Rhamnus songorica Gontsch.	-	+	-
Berberis iliensis Popov	-	+	-
Betula jarmolenkoana Golosk.	-	-	+
Zygophyllum cuspidatum Boriss.	+	-	-
Lepidium rubtzovii Vass.	+	-	-
Alchemilla michelsonii Juz.	-	-	+
Alchemilla liscphitzii Juz.	-	-	+
Astragalus rubtzovii Boriss.	+	-	-
Astaragalus amabilis M.Pop.	-	-	+
Astragalus saccocalyx Schrenk.	-	-	+
Astragalus dscharkenticus M. Pop.	-	-	+
Astaragalus abramovii Gontsch.	-	-	+
Astragalus chlorodontus Bunge	-	-	+
Astragalus semenovii Bunge	-	-	+
Astragalus tekessicus Bajt.	-	-	+
Oxytropis ketmenica Saposhn.	+	-	-
Oxytropis cana Bunge.	-	-	+
Oxytropis bosculensis Golosk.	-	-	+
Seselopsis tianschanica Schischk.	-	-	+
Lappula ketmenica Kudabaeva.	-	-	+
Pedicularis maximowiczii Krasn.	-	-	+
Phlomoides zenaidae (M. Pop.) Adyl. R. Kam. & Machmedov.	-	-	+
Lagochilus kaschgaricus Rupr.	-	-	+
Erigeron violaceus M. Pop.	-	-	+
Galatella tianschanica Novopokr.	-	-	+
Galatella polygaloides Novopokr.	+	-	-
Galatella saxatilis Novopokr.	-	-	+
Galatella regelii Tzvel.	-	-	+
Pyrethrum semenovii (Herd.) O. & B. Fedtsch.	-	-	+
Kaschgaria brachanthemoides (C. Winkl.) Pojak.	-	-	+
Artemisia transiliensis Pojak.	-	-	+
Ligularia knorringiana Pojak.	-	-	+
Saussurea caespitans Iljin.	-	-	+
Saussurea sallemani S. Winkl.	-	-	+
Saussurea ninae Iljin.	-	-	+
Scorzonera transiliensis M.Pop.	-	-	+
Taraxacum calcareum V. Korol.	-	-	+
Allium lasiophyllum Vved.	-	-	+
Elymus glaucissimum (M.Pop.) Tzvel.	-	-	+
Tulipa heterophylla (Regel) Baker	-	-	+
Tulipa brachystemon Regel.	-	-	+
Tulipa iliensis Regel	-	-	+
Tulipa kolpakowskiana Regel	-	+	-

Biomorphological Analysis

Serebryakov and Raunkier (1962) were applied to compile the classification system of life forms for the analysis of endemic and subendemic species of the Ketpen ridge where the following life forms are distinguished (Table 4).

In the analysis of life forms of the Ketpen ridge endemic and subendemic plant species according to Serebryakov and Raunkier (1962), it has been detected that 95,0% is represented by perennial grasses, the overwhelming majority of which refers to taproot polycarpous plants (58,6%) which is explained by the climatic conditions common to moderate flora. The largest number of taproot plants is concentrated in the families of Fabaceae (11 species), Asteraceae (7 species), Brassicaceae (4 species), Lamiaceae (2 species), Boraginaceae (1 species). A small number of short- rhizomatous polycarpous plants are represented by only 3 species (7,5%) which predominate in the families of Rosaceae (2 species) and Asteraceae (1 species). The share of suffrutices and dwarf subbshrubs is only 2 species (5,0%) that are represented in the family of Asteraceae.

The distribution of endemic and subendemic plant species according to the life forms of Raunkire has shown that basic mass (40 species) out of the total number of species (46 species) belongs to hemicryptophytes, i.e., redivives and the share of chamaephytes account for only 4 species.

The distribution of the Ketpen ridge endemic and subendemic species in ecological groups (ecotypes) has shown that half of the endemic and subendemic species (25 species) belongs to the type of petrophilous plants that is common to rocky and rubbly habitats. Some species due to their environmental fitness can be found simultaneously in several habitats. For instance, petrophylous species usually grow not only on rocky slopes, but they are often found on pebbles, rocks, steppes and etc. They are widely found in the families of Asteraceae (10 species), Fabaceae (6 species), Brassicaceae (2 species), Alliaceae (1 species), Poaceae (1 species), Zygophyllaceae (1 species). Among the remaining groups, 7 species are steppe and 7 species are meadow and 1 species belongs to psammophytes. Thus, most of the endemic and subendemic ridge plants belong to rocky and rubbly habitats.

Classification of Plants Based on Environmental Conditions and the Type of Substrate

According to Prokopiev (1995), an ecological group reflects the ratio of plants to a single factor and combines species that respond equally to a particular factor necessary for their normal development in similar intensities of the given factor and having close values of the optimum points.

The Ratio of Species to Moisture

Ecological group reflects the attitude of plants to any one factor. It unites species that react approximately equally to a particular factor, which need for their normal development in similar intensities of the given factor and have close values of the optimum points (Prokopiev, 1995).

All rare endemic and subendemic species of the flora of the Ketpen ridge are divided into the following ecological groups.

With Respect to Plants to Moisture

Mesophytes-plants with enough moistened habitats (Erysimum croceum, Kaufmannia semenovii, Oxytropis ketmenica).

Xerophytes are plants capable of carrying, while remaining active, a continuous dryness of air and soil. This ecological group includes the following species: Artemisia transiliensis, Rhamnus songarica, Zygophyllum cuspidatum and others. Intermediate forms are distinguished, such as: mezoxerophytes (Saussurea caespitans, Lepidium rubtzovii, Astragalus chlorodonthus).

Our ecological analysis has shown that rare endemic and subendemic species are represented by mesophytes - 32 species or 68.0% of the total number of species.

In the flora are also widely represented mezoxerophytes - 8 species or 17% and xerophytes of 7 species or 14%. This ratio is typical for the mountain regions of Central Asia (Fig. 5).

The Ratio of Species to Stony, Gravelly and Other Substrates

Structural analysis of the composition of endemic and subendemic species of the plants of the Ketpen ridge made it possible to determine the different degree of ecological confinement to habitat conditions.

With respect to the substrate, endemic and subendemic species are subdivided into the following habitat types: (Table 5). Endemic and subendemic species are dominated by stony habitats of various variants of stony and gravelly slopes (25 species or 53.2%). The remaining endemic and subendemic species grow on the slopes of mountains and hills with outcrops of rocks, on moist forest meadows, solonetzic meadows, sandy and other soils, which have 22 species or 46.8%.

According to the seasonal rhythm, the endemic and subendemic species of the Ketpen ridge are represented by the spring-flowering species to which the genus Tulipa belongs (*Tulipa heterophylla, T.brachystemon, T. Iliensis, T. Kolpakowskiana*) the period of vegetation is up to 60 days (April-May), as well as the spring-autumn-flowering (*Astragalus rubtzovii, Kaufmannia semenovii, Ikonnikovia kaufmanniana, Phlomoides zenaidae*) and spring-summer-autumn-flowering long-vegetating species (*Artemisia transiliensis, Galatella tianschanica, Kaschgaria brachanthemoides, Astragalus chlorodontus*) the period of vegetation is up to 150 days.

Table 4. Distribution of endemic and subendemic plants of the Ketpen ridge according to life forms

Life form	Number of species	% of the total number of species
1. Arbors (trees)	1	2,1
2. Shrubs	1	2,1
2. Suffrutices and dwarf subbshrubs	4	6,5
2 Terraneous herbaceous plants		
2.1 Redivives	40	87,1
3 Taproot polycarpous plants	28	58,6
3.1 Taproot polycephalous perennial plants	7	15,2
4 Short-rhizomatous polycarpous plants		
4.1 Short-rhizomatous redivives	3	6,5
5 Caespitose perennial plants		
5.1 Loose-caepitose perennial plants	1	2,1
6 Tuberiforming redivives	1	2,1
7 Bulbaceous redivives	5	10,8
Total:	47	100

Table 5. Habitat for endemic and subendemic species of the Ketpen ridge

Type of habitat	Total number of species	% of the total number of species
Slopes of mountains and hills	3	6,3
Rocks, cliffs	2	4,2
Mountain rivers	2	4,2
Solonetzic meadows	8	10,6
Stony and gravelly slopes	25	53,2
Moist forest meadows	6	12,7
Sand massif	1	2,3
Total:	47	100

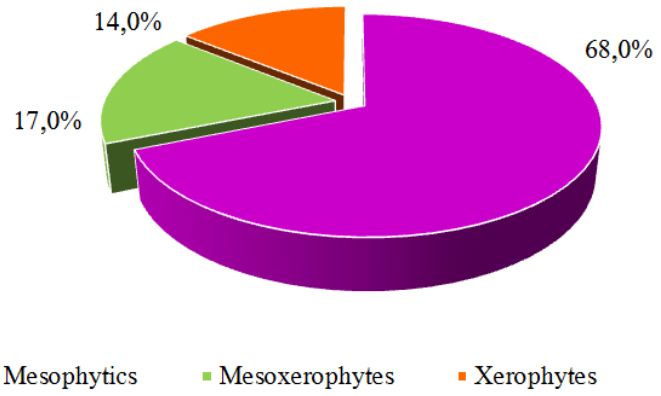

Fig. 5. The ratio of ecological groups of rare, endemic and subendemic plants in relation to moisture

Discussion

In the course of the study, taxonomic, geographic, biomorphological and ecological analysis of the endemic and subendemic flora of the Ketpen ridge was carried out.

The general list of endemic and subendemic species of the Ketpen ridge flora has been compiled. The largest families are Asteraceae which contains 15 species or 32,9% of the total composition. The *Fabaceae* family-11 species (23,4%) is second in line, the Brasicaceae and Liliaceae families - 4 species (8,7%) are in the third and fourth place. The family Rosaceae and Lamiaceae contain only 2 species (4,3%). Other 11 families - Plumbaginaceae, Scrophulariaceae, Berberidaceae, Poaceae, Zygophyllaceae, Alliaceae, Rhamnaceae, Boraginaceae, Betulaceae, Primulaceae, Apiaceae have 1 species or 24,0%. Biomorphological analysis has shown that the life forms of endemic and subendemic plants of the Ketpen ridge are allocated as follows: perennials - 40 species (87,1%), corms -1 (2,1%), shrubs - 1 species (2,1%), suffrutices - 1 species (2,1%), dwarf subshrubs - 3 species (6,5%), arbors (trees) - 1 species (2,1%).

In study tests of life forms under Serebryakov and Raunkier (1962), we have found that 87,1% of the endemic and subendemic species of the Ketpen ridge flora is represented by emicryptophytes, the

overwhelming majority of which belongs to taproot polycarpous plants which is due to climatic conditions and is common to moderate floras.

Conclusion

Until recently the flora of endangered endemic and subendemic species of the Ketpen ridge has not been studied by anyone. Complex studies of rare endemic and subendemic species and analysis of all obtained results have not been conducted in the territory of the Ketpen ridge which stipulates the urgency of such studies. As the result of the analysis, we have discovered 46 endemic and subendemic species of the Ketpen ridge flora represented by 28 genera and 17 families, where endemism in the Ketpen ridge flora is expressed only at a species level.

Acknowledgement

The work has been carried out within the scope of research grant "Biological diversity of endangered, endemic and subendemic plant species of Ketpen ridge and elaborating recommendations for their conservation".

Author's Contributions

All authors equally contributed in this work.

Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and no ethical issues involved.

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